

**Research Development Fund – Fall FY16 Cover Page Template**

**SUBMISSION DEADLINE: September 15, 2015 at 12 noon CDT to [rdf@tamu.edu](mailto:rdf@tamu.edu)**

(All cover pages will be posted for the campus community to view at <http://rdf.tamu.edu/abstracts>)

**Proposal Title:** Texas Powerplant Efficiency and Environmental Impact Facility: Advanced Experimental Capability for the Gas Turbines of the Future

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**Key Participating units:** Engineering, Agriculture & Life Sciences, Geosciences, Science, Health Science Center

**Anticipated Request Amount (\$):** \$1.2M

**Executive summary of the intended proposal.**

In 2012, 67.9% of world electricity generation, which amounted to 22,668 TWh, was generated using fossil fuels in gas turbine engines that operate following the Brayton cycle. The Brayton cycle, however, is not capable of maximum efficiency because of inherent irreversibility. Alternative thermodynamic cycles are capable of higher efficiency and net work, and lower emissions. An efficiency increase of just one point translates to 380 TWh per year, i.e., \$38 billion/year calculated using 10 cents/kWh. We estimate that the cycle efficiency can be increased by 10 points or more, which translates to a savings of 24.7% of the total world energy generated using fossil fuels based on 2012 data. Additionally, using the new technology that will be developed, the NO<sub>x</sub> and unburned hydrocarbon emissions will be decreased, due to the lower combustion temperature.

We propose the creation of a user facility for the development of a new generation gas turbine based on a more efficient thermodynamic cycle, which will impact power generation, terrestrial, naval and air transportation, and defense. This facility will foster collaboration of faculty across all colleges at TAMU and will be a unique resource to the State of Texas and the Nation. The facility will combine state-of-the-art diagnostics in an operational gas turbine/jet engine test cell, and will allow researchers from the Colleges of Engineering, Science, Geosciences, Agriculture & Life Sciences, and from the Health Science Center to conduct multidisciplinary research for future, more efficient and cleaner powerplants.

The proposed facility will foster collaboration between researchers in all colleges and the Health Science Center to develop game-changer technologies for a new generation of gas turbines. We anticipate building an extensive experimental infrastructure that would impact research across many different disciplines. To that end we advocate the use of non-intrusive, advanced laser diagnostics as well as extractive sampling techniques in diverse apparatuses. Those include an open turbine/combustor simulator system, which will mimic the flowfield inside a turbine, but do so at ambient atmospheric conditions; and an actual power generating turbine/jet engine, where accurate measurements can be performed on the exhaust gases. For example, chemical species that are considered atmospheric pollutants, such as the oxides of nitrogen (NO<sub>x</sub>) and sulfur (SO<sub>x</sub>), unburned hydrocarbons (HC), and other volatile organic compounds (VOC), can all be quantified by laser diagnostics or extractive sampling. Their production rates may be understood in their precise chemical detail by the use of detailed chemistry computations. The effect of biofuel composition on pollutant production may be quantified by analyzing the environmental impact of various fuels throughout their lifecycle from crop to (bio)fuel. This will provide important data for assessing the potential health effects of emissions from an actual powerplant. All these are broader issues that far exceed the narrow engineering and economic aspects of power generation, and affect research at a grand scale across Texas A&M.